Electronics and Electrical Communication Engineering Department
Third year

Sheet (1) Sound Waves

Uses the following values as needed unless otherwise specified: the equilibrium density of air at 20℃ is ρ=1.20 kg/m^2, the speed of sound in air is v=343m/s.

1- Suppose that you hear a clap of thunder 16.2 s after seeing the associated lightning stroke. The speed of sound waves in air is 343m/s, and the speed of light is$3.00 \times 10^8\ m/s$. How far are you from the lightning stroke?

2- Find the speed of sound in mercury, which has a bulk modulus of approximately $2.80 \times 10^{10} N/m^2$ and a density of $13600 kg/m^3$.

3- In dry air the temperature decreases about 1°C for 150 m rise in altitude. (a) Assuming this change is constant up to an altitude of 9000m, how long will it take the sound from an airplane flying at 9000m to reach the ground on a day when the ground temperature is 30°C? (b) What if? Compare this to the time interval required if the air temperature were a constant 30°C. Which time interval is long?

4- A sound wave in air has a pressure amplitude equal to $4.00 \times 10^{-3} N/m^2$ .Calculate the displacement amplitude of the wave at a frequency 10.0 kHz.

5- A sinusoidal sound wave is described by the displacement wave function

$$s(x,t) = (2.00\ \mu m)\ cos[(15.7 m^{-1})x - (858 s^{-1})t]$$

(a) Find the amplitude, wavelength, and speed of this wave.
(b) Determine the instantaneous displacement of air at the position x=0.050m at t=3.00 ms.

6- As a certain sound wave travels through the air, it produces a pressure variations (above and below atmospheric pressure) given by $\Delta P = 1.27\sin(\pi x - 340\pi t)$ .Find
(a) The amplitude of the pressure variations.
(b) The frequency, the wavelength and the speed of the sound wave.

7- Write an expression that describes the pressure variations as a function of position and time for a sinusoidal sound wave in air, if λ =0.100m and Δp_{max}=0.200 N/m^2.

8- Write the function that describes the displacement wave corresponding to the pressure wave in the previous problem.

9- An experimenter wishes to generate in air a sound wave that has a displacement amplitude of $5.5 \times 10^{-6} m$.The pressure amplitude is to be limited to 0.840 N/m^2.What is the minimum wavelength the sound wave can have?

10- The faintest sounds the human ear can detect at a frequency 1000Hz correspond to an intensity about $1.00 \times 10^{-12} W/m^2$ –the so-called threshold of hearing. The loudest sounds the ear can tolerate at this frequency correspond to an intensity about $1.00 W/m^2$ of threshold of pain. Determine the pressure amplitude and displacement amplitude associated with these two limits.

11- A point source emits sound waves with an average power output of 80.0 W
(a) Find the intensity 3.00 m from the source
(b) Find the distance at which the intensity of sound is$1.00 \times 10^{-8} W/m^2$.

12- The area of a typical air drum is about $5.00 \times 10^{-5} m^2$.Calculate the sound power incident on an air drum at (a) the threshold of hearing and (b) the threshold of pain.

13- Two identical machines are positioned the same distance from a worker. The intensity of sound delivered by each machine at the location of the worker is $2.00 \times 10^{-7} W/m^2$.Find the sound level heard by the worker
(a) When one machine operating.
(b) When both machines are operating.

14- Calculate the sound level in decibels of a sound wave that has an intensity of 4.00μW/m^2.